

Extrapolation of the aerosol reflectance from the near-infrared to the visible: the single-scattering epsilon vs multiple-scattering epsilon method

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Abstract. In the atmospheric correction algorithm for Sea-viewing Wide Field-of-view Sensor, the effects of the spectral variation of the aerosol radiance contributions at the two near-infrared (NIR) bands are estimated directly from sensor-measured radiance. The aerosol effects at the NIR are then extrapolated into the visible through a process of aerosol model selection from evaluation of the NIR single-scattering epsilon value, which is defined as the ratio of the single-scattering aerosol reflectance between two NIR bands. The aerosol radiance contribution at the visible wavelengths is then removed. In this paper, a slightly different approach in the aerosol model selection and extrapolation, i.e. using the NIR multiple-scattering epsilon instead of the single-scattering epsilon, is examined. The NIR multiple-scattering epsilon is the ratio of the aerosol multiple-scattering reflectance between two NIR wavelengths. Simulations show that, in general, both methods give comparable results. Statistically, more than 95% of cases in the retrieved ocean colour spectrum are within required accuracy for both methods. For clear atmosphere, however, the results of the atmospheric correction using the single-scattering epsilon method usually performed slightly better than the multiple-scattering epsilon method. On the other hand, for the large aerosol optical thickness the multiple-scattering epsilon method has slightly better retrievals for the Tropospheric aerosols. Some detailed analyses and discussions are provided to explain differences in these two approaches for extrapolating and retrieving the aerosol effects in the visible.

1. Introduction

The atmospheric correction algorithm (Gordon and Wang 1994a, Gordon 1997) for Sea-viewing Wide Field-of-view Sensor (SeaWiFS) (Hooker *et al.* 1992) uses the aerosol information derived from the SeaWiFS two near-infrared (NIR) bands (centered at 765 nm and 865 nm) and then extrapolates it into the visible wavelengths through evaluation of the aerosol parameter, i.e. single-scattering epsilon (SSE) values (Gordon and Wang 1994a, Wang and Gordon 1994a). The same algorithm is also used for the retrieval of the ocean colour products from the Moderate Resolution Imaging Spectroradiometer (MODIS) (Salomonson *et al.* 1989, Esaias *et al.* 1998). Alternatively, the aerosol optical properties derived at the two NIR bands can be extrapolated using the parameter of multiple-scattering

epsilon (MSE) values (Su 2000). The MSE parameter was studied and discussed by Gordon and Castaño (1987) and Antoine and Morel (1999). These two approaches are essentially the same as in retrieval of the aerosol optical and radiative properties in the visible. However, the optical and radiative properties of the aerosol SSE and the MSE are different, leading to slightly different results in the performance of the atmospheric correction for the ocean colour remote sensing. In this paper, the efficacy of the aerosol correction algorithm using the methods of the SSE versus the MSE is compared. First, both the SSE and MSE methods in deriving the aerosol optical properties are briefly described. The differences in the spectral distribution of the SSE and MSE for the various aerosol models are then discussed. Next, simulations are carried out to compare performance of the two approaches in retrieving the ocean signals. Finally, results that explain the slight differences in the algorithm performance with the SSE and MSE methods are provided.

4. Conclusions

A study has been carried out to compare the performance of the aerosol correction algorithm using the NIR SSE and MSE values for the ocean colour remote sensing. In comparison with the SSE, which depends on the aerosol model and the solar-sensor geometry, the MSE is also dependent on the Rayleigh and aerosol optical thicknesses (in addition to the aerosol model and geometry dependents). Simulations show that, for realistic situations in which aerosols are similar to but different from the look-up table aerosol models, both methods, in general, performed extremely well. Statistically, both methods provide results with $>95\%$ of the retrieved $[\rho_w(\lambda)]_N$ that are within the required accuracy at the visible wavelengths. The SSE method, however, performed slightly better for cases with very clear atmosphere (low aerosol optical thickness) and for the M80 aerosol model. This is mainly due to a slightly better aerosol model selection and a weight computation from the NIR SSE values in these cases. On the other hand, for the cases of the Tropospheric model, for which the MSE as a function of wavelength is well defined with various RH values, the MSE method has slightly better retrievals than the SSE method for the T80 model with aerosol optical thickness $> \sim 0.1$.